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SPOKANE VALLEY-RATHDRUM PRAIRIE AQUIFER,
WASHINGTON AND IDAHO

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ABSTRACT

The Spokane Valley-Rathdrum Prairie aquifer is composed of unconsolidated Quaternary glaciofluvial deposits underlying an area of about 350 square miles. Transmissivities in the aquifer range from about 0.13 million to 11 million feet squared per day and ground-water velocities exceed 60 feet per day in some areas. The water-table gradient ranges from about 2 feet per mile to more than 60 feet per mile, and during a year the water table fluctuates on the order of 5 to 10 feet. For most of the aquifer the water table is between 40 and 400 feet below land surface. The aquifer is recharged and discharged at an average rate of about 1,320 cubic feet per second.

Water is presently (1976) pumped from the aquifer at an average rate of about 239 cubic feet per second for domestic, industrial, and agricultural uses. Most of this is discharged to the Spokane River, lost to evapotranspiration, or applied to the land surface with little or no change in quality. However, about 34 cubic feet per second becomes waste water generated by domestic and industrial activities and is returned to the aquifer by percolation from cesspools and drain fields.

The quality of water in the aquifer is generally good. Less than one-half of 1 percent of the 3,300 analyses available exceeded the maximum contaminant levels specified in the National Interim Primary (or Proposed Secondary) Drinking Water Regulations (U.S. Environmental Protection Agency, 1975) for constituents which may be hazardous to health. Of the 6,300 analyses for constituents considered detrimental to the esthetic quality of water, about 1.4 percent have yielded values which exceeded the recommended levels.

Alternative water sources for the area supplied by the aquifer are the Spokane and Little Spokane Rivers, lakes adjacent to the aquifer, and other aquifers. All of these potential sources are less desirable than the Spokane Valley-Rathdrum Prairie aquifer because of insufficient supplies, poor water quality, and (or) remoteness from the areas of need.

INTRODUCTION

Purpose

The U.S. Environmental Protection Agency (EPA) has been petitioned for "sole source" designation of the Spokane Valley-Rathdrum Prairie aquifer of Washington and Idaho (pl. 1, in pocket) in accordance with the 1974 Federal "Safe Drinking Water Act" (Public Law 93-523). If the aquifer is determined to be the only economical source of safe drinking water capable of supplying the Spokane Valley-Rathdrum Prairie area, then a "sole source" designation can be assigned by EPA. This would give EPA the responsibility of protecting the quality of water in the aquifer from any detrimental effects caused by any Federal financially assisted projects in the area.

The purpose of this report is to describe the hydrologic characteristics, patterns of water use and disposal, quality of water in the aquifer, and alternative water sources for the area served by the aquifer. The report is based on available basic data and previous studies in the area and is intended for use as a decisionmaking aid in the disposition of the "sole source" petition.

Previous Investigations

The earliest studies of the Spokane Valley-Rathdrum Prairie aquifer were by Fosdick (1931) and Newcomb (1933), both of whom outlined some basic geologic, physiographic, and hydrologic features of the aquifer and its recharge area. Newcomb concluded that a buried ridge of basalt near Spokane causes the ground-water flow to divide, one part moving northward into the Hillyard Trough, another part moving westward into the basalt, and a third part moving through the Miocene Latah Formation into underlying basalt. Both authors suggested that the water flowing through the Hillyard Trough (the area between Fivemile and Orchard Prairies, Wash.; pl. 2), emerges as springs along the south side of the Little Spokane River valley. Newcomb indicated that the Spokane River is a losing stream between Post Falls, Idaho, and Trent, Wash., and a gaining stream from Trent to Spokane. The two authors disagreed on the major source of recharge to the aquifer; Newcomb claimed Pend Oreille Lake as the source, while Fosdick suggested that precipitation directly over the aquifer and in adjacent highlands is the source.

Piper and Huff (1943), Huff (1943), and Piper and La Rocque (1944), studied the aquifer in more detail. Piper and Huff measured water levels in a series of wells and made estimates of the hydraulic gradient in different parts of the aquifer. They concluded that Hayden, Coeur d'Alene, and Pend Oreille Lakes, and the Spokane River are the major sources of recharge, with Pend Oreille Lake making the greatest contribution. They also estimated that the discharge from the aquifer to springs and rivers was 900 ft³/s.

DATA-BASE DESCRIPTION AND DISCUSSION

Aquifer

Geology

The Spokane Valley-Rathdrum Prairie aquifer is composed predominantly of Quaternary glaciofluvial deposits which extend from Pend Oreille Lake, Idaho, to Long Lake, Wash., and cover an area of about 350 square miles (pl. 1). The deposits consist mostly of sand and gravel, fine to coarse, and are poorly to moderately sorted, having scattered cobbles and boulders. Some beds are composed almost exclusively of cobbles and boulders as well as a few scattered clay lenses. The sand and gravel is relatively free of fine sand and silt, except in the uppermost 3 to 5 feet, where fine-grained materials fill most voids in the sand and gravel. In the Hillyard Trough, the sediments become progressively finer grained toward the north, where the aquifer is composed predominantly of stratified sand but includes some gravel and silt and a few boulders.

In most areas, the aquifer probably overlies the semiconsolidated, fine-grained Latah Formation of Miocene age. In some areas the aquifer has abrupt lateral contacts with sloping bedrock surfaces, but in other areas, it grades laterally into less permeable, unconsolidated materials which are not readily distinguishable from the aquifer materials. In such places, the selected aquifer boundaries (pl. 2) are somewhat arbitrary. The aquifer boundaries were extended up the small tributary valleys below Newman and Liberty Lakes, Wash., to include all the unconsolidated materials. Rather arbitrary boundaries were drawn across Saltese Flats and Peone Prairie, Wash., because of insufficient subsurface data. Placement of the boundary between Pend Oreille and Hayden Lakes, Idaho, excludes a large area of unconsolidated materials which are not considered part of the aquifer. These materials are believed to be relatively thin and to directly overlie bedrock, and they have high water-table altitudes (generally above 2,200 ft) which do not fit the overall flow pattern in the aquifer. Boundaries were not drawn across the Spirit and Hoodoo Valleys in Idaho because of insufficient subsurface data.

The thickness of the aquifer is not well established. The best data exist where two seismic surveys have supplemented available drilling data. The seismic data (Newcomb, 1953) indicate a total thickness of about 400 feet of unconsolidated materials near the Idaho-Washington State line. Because the water table is at a depth of about 120 feet, the saturated thickness of the aquifer is approximately 280 feet.

In the Hillyard Trough, a test hole showed about 780 feet of unconsolidated material (Rieber and Turner, 1963). Newcomb's seismic interpretation for the same area designated about 160 feet of these materials as the saturated part of the aquifer, about 150 feet as

unsaturated materials above the aquifer, and the rest as Latah Formation underlying the aquifer.

The only other wells that penetrate the entire thickness of the aquifer do so near its margins, in the thinner parts of the aquifer. Wells drilled away from the margins generally penetrate only 50 feet or less below the water table because sufficient supplies of water are generally found within this part of the aquifer.

Hydraulic Characteristics

The transmissivity of the aquifer (the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient) is generally high. Values calculated by the U.S. Geological Survey's computer model range from 0.13 million to 11 million ft^2/day (pl. 3). The values shown in plate 3 are averages for designated parts of the aquifer and are based on calculated flow rates and observed water-table gradients. Transmissivities calculated from pumping tests at individual wells range from less than 0.13 million ft^2/d in the western end of the aquifer to more than 13 million ft^2/d near the Washington-Idaho State line.

The specific yield of the aquifer--the ratio of (1) the volume of water which the aquifer, after being saturated, will yield by gravity to (2) the volume of the aquifer--cannot be accurately calculated with the available data. Most unconfined aquifers have values of specific yield ranging from 0.1 to 0.3, and the Spokane Valley-Rathdrum Prairie aquifer, at least in its upper 50 feet of saturated section, is probably nearer to the 0.3 value.

Calculated values of ground-water velocities are high. Assuming a saturated thickness of 280 feet, a transmissivity of $3.4 \times 10^6 \text{ ft}^2/\text{day}$, a water-table gradient of 7 ft/mile, and a porosity of 0.25 for the aquifer at the State line, the calculated velocity is about 64 ft/day. In an earlier study (U.S. Army Corps of Engineers, 1976) a different set of estimated aquifer characteristics led to a calculated velocity of 90.5 ft/day. For the Hillyard Trough, assuming a saturated thickness of 160 feet, a transmissivity of $0.4 \times 10^6 \text{ ft}^2/\text{day}$, a water-table gradient of 30 ft/mile and a porosity of 0.30, the calculated average velocity is 47 ft/day. In the Corps of Engineers study, the velocity was calculated to be 41.1 ft/day.

Rates of ground-water flow of about 960 and 350 ft^3/s were calculated at the State line and in the Hillyard Trough, respectively, assuming the above transmissivity and gradient values and aquifer widths of 3.5 and 2.5 miles, respectively. The rates calculated in the U.S. Army Corps of Engineers (1976) study were 1,000 and 200 ft^3/s , respectively. The estimated rates of 960 and 350 ft^3/s closely agree

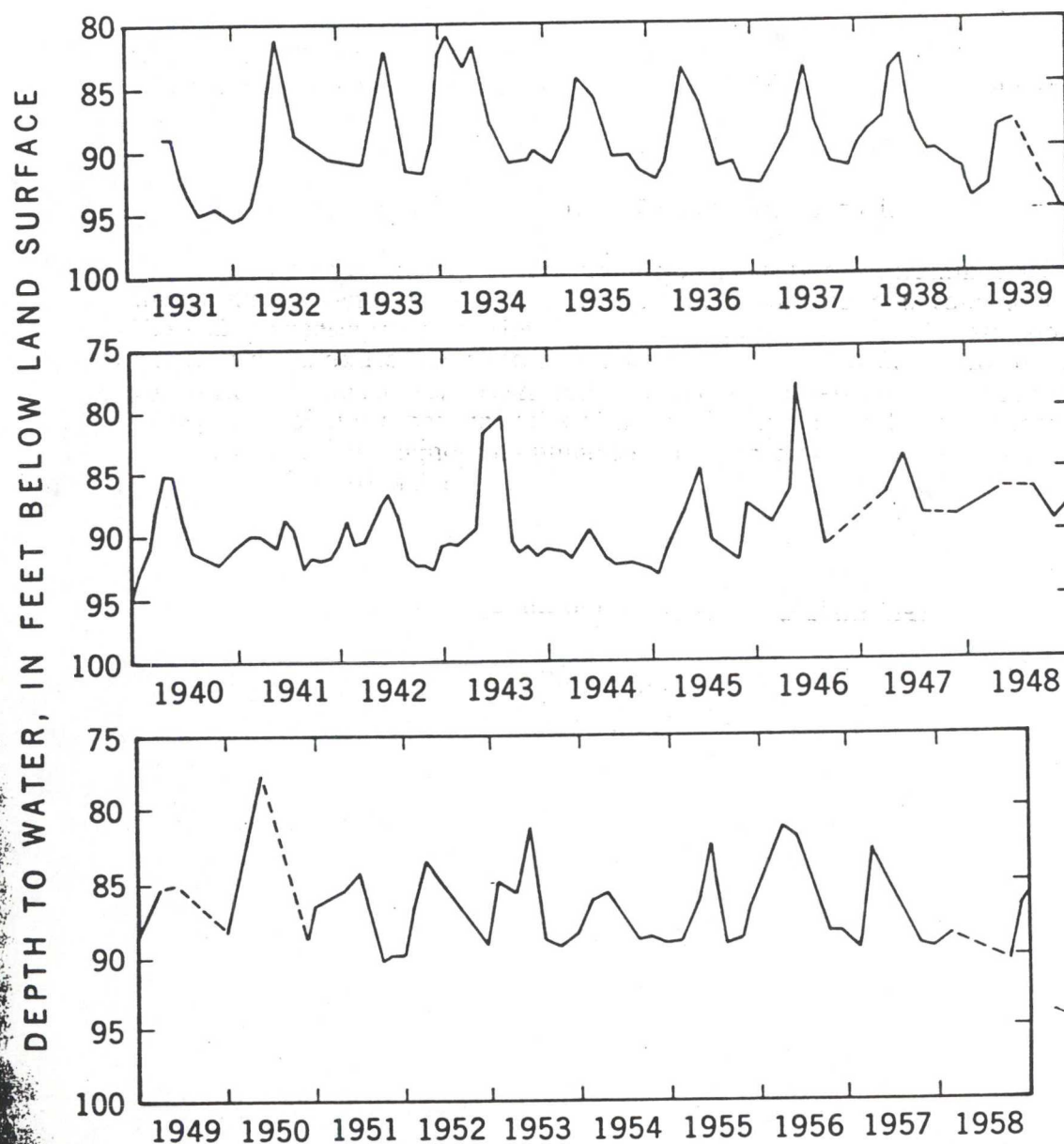
with the ground-water budget obtained from estimated rates of recharge and discharge. (See section on recharge to and discharge from the aquifer.) From the ground-water budget (pl. 4) a flow of 930 to 1,010 ft^3/s is indicated near the State line. Also, the budget shows a gain of 310 ft^3/s in the Little Spokane River, which is derived almost entirely from the discharge of water from the aquifer at the northern end of the Hillyard Trough.

Water Levels

The water table in the aquifer slopes from Hoodoo Valley and Lake Pend Oreille, Idaho, to Nine Mile Falls, Wash. It is at a maximum altitude of about 2,180 feet in northern Idaho and declines to about 1,540 feet near Nine Mile Falls. The water table in the northernmost part of the aquifer slopes about 20 ft/mile, while the major part, from north of Round Mountain, Idaho, to the southern end of the Hillyard Trough in Washington slopes relatively gently, from 2 to 10 ft/mile. The steepest slopes are in parts of the Hillyard Trough where the water table slopes more than 60 ft/mile. The mean annual altitude of the water table is shown on plate 2.

The water-table contours on plate 2 are by no means the only possible, reasonable interpretation of the available data and reflect at best an estimated average annual condition. Water-level data are maintained primarily by the U.S. Geological Survey, which has computer files of more than 16,000 water levels from about 430 wells tapping the aquifer in Washington and from about 200 wells tapping the aquifer in Idaho. These water-level data are of various qualities, including those reported by owners and well drillers, those measured by U.S. Geological Survey personnel, and those recorded by monitoring devices installed in selected wells. The data represent a long period of time, from the earliest measurements in about 1920 to the present. As shown in the hydrographs of 11 wells (figs. 1-11), water-level fluctuations are usually less than 15 feet during a year in most areas. Generally, the greatest annual fluctuations occur in those wells nearest to the Spokane River, in response to changing stages of the river.

The water table is deepest in northern Idaho, about 300 to 400 feet below the land surface, and becomes gradually shallower downgradient, reaching depths of about 120 feet at the Washington-Idaho State line and about 40 feet near Spokane, Wash. Continuing downgradient, the depth to the water table increases to about 150 feet in the Hillyard Trough.



Well number: 25/44-23D1;

Depth: 97 ft.;

Water use: Irrigation.

FIGURE 3.--Water-level fluctuations in well 25/44-23D1, 1931-77.